

REMARKS

Applicants respectfully acknowledge receipt of the Final Office Action mailed May 30, 2007.

In the Final Office Action, the Examiner rejected claims 1-4 under 35 U.S.C. § 102(e) as being anticipated by *Li et al.* (U.S. Patent No. 6,284,149); rejected claim 5 under 35 U.S.C. § 103(a) as being unpatentable over *Li*; and rejected claim 14 under 35 U.S.C. § 103(a) as being unpatentable over *Li* in view of *Jiang et al.* (U.S. Patent No. 6,455,411).

By this Amendment, Applicants propose to amend claims 1 and 14 and add new claim 18. Upon entry of this Amendment, claims 1-5, 14, and 18 will be pending. Of these claims, claims 1, 14, and 18 are independent. Claims 6-12 and 15-17 were previously canceled in the "Amendment After Final" filed September 4, 2003, and claim 13 was previously canceled in the "Reply to Office Action" filed June 21, 2004.

The originally-filed specification, claims, abstract, and drawings fully support the amendments to claims 1 and 14 and the addition of claim 18. No new matter has been introduced.

Applicants traverse the rejections above and respectfully request reconsideration for at least the reasons that follow.

I. 35 U.S.C. § 102(e) REJECTION

Claims 1-4 stand rejected under 35 U.S.C. § 102(e) as being anticipated by *Li*. Applicants respectfully disagree with the Examiner's arguments and conclusions and submit that independent claim 1 patentably distinguishes over *Li* at least for the reasons set forth below.

In order to properly establish that *Li* anticipates Applicants' claimed invention under 35 U.S.C. § 102, each and every element of each of the claims in issue must be disclosed, either expressly described or under principles of inherency, in that single reference. Furthermore, "[t]he identical invention must be shown in as complete detail as is contained in the ... claim." See M.P.E.P. § 2131, quoting *Richardson v. Suzuki Motor Co.*, 868 F.2d 1126, 1236, 9 U.S.P.Q.2d 1913, 1920 (Fed. Cir. 1989).

Li discloses a plasma etching process for etching a carbon-based low-k dielectric layer in a multi-layer inter-level dielectric. The low-k dielectric may be BCB, which contains about 4% silicon, the remainder being carbon, hydrogen, and a little oxygen. The BCB etch uses an etching gas of oxygen, a fluoro carbon, and nitrogen, but no argon (emphasis added). (*Li*, Abstract). The multi-layer inter-level dielectric includes a substrate 10, a lower stop layer 14, a low-k lower dielectric layer 16, an upper stop layer 18, a low-k upper dielectric layer 20, and a hard mask layer 42. (*Id.* at col. 6, line 56 - col. 7, line 31).

Li, however, fails to disclose the BCB etch using a processing gas containing N₂ and CF₄. In fact, as admitted by the Examiner, "*Li* does not teach etching BCB with a mixture of CF₄ and N₂."

Accordingly, with respect to independent claim 1, *Li* fails to teach or suggest the claimed combination, including, *inter alia*:

"introducing a processing gas into the airtight processing chamber, the processing gas containing N₂ and CF₄" (emphasis added).

The Examiner has therefore not met the essential criteria for showing anticipation, wherein "each and every element of each of the claims in issue must be

found, either expressly described or under principles of inherency, in...a...single reference.” See M.P.E.P. § 2131. Accordingly, independent claim 1 is patentable over *Li*. Applicants therefore request that the rejection of claim 1 under 35 U.S.C. § 102(e) be withdrawn and claim 1 be allowed.

Moreover, claims 2-4 are in condition for allowance at least due to their dependence from independent claim 1. In addition, at least some of the dependent claims may recite unique combinations that are neither disclosed nor suggested by the cited art, and therefore some also are separately patentable.

II. 35 U.S.C. § 103(a) REJECTIONS

Claim 5 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Li*. As explained above, with respect to independent claim 1, *Li* fails to disclose or suggest, *inter alia*, “introducing a processing gas into the airtight processing chamber, the processing gas containing N₂ and CF₄,” as required by claim 1 (emphasis added). Claim 5 is therefore patentable over *Li* at least due to its dependence from claim 1. Applicants therefore request that the rejection of claim 5 under 35 U.S.C. § 103(a) be withdrawn and claim 5 be allowed.

Claim 14 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Li* in view of *Jiang*. Applicants respectfully disagree with the Examiner’s arguments and conclusions and submit that independent claim 14 patentably distinguishes over *Li* and *Jiang* at least for the reasons described below.

In order to establish a *prima facie* case of obviousness under 35 U.S.C. §103(a), each of three requirements must be met. First, the reference or references, taken alone

or combined, must teach or suggest each and every element recited in the claims.

Second, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the references in a manner resulting in the claimed invention. Third, a reasonable expectation of success must exist. Moreover, each of the three requirements must "be found in the prior art, and not be based on applicant's disclosure." See M.P.E.P. §2143, 8th ed., February 2003.

Li discloses a plasma etching process for etching a carbon-based low-k dielectric layer in a multi-layer inter-level dielectric. The low-k dielectric may be BCB, which contains about 4% silicon, the remainder being carbon, hydrogen, and a little oxygen. The BCB etch uses an etching gas of oxygen, a fluoro carbon, and nitrogen, but no argon (emphasis added). (*Li*, Abstract). The multi-layer inter-level dielectric includes a substrate 10, a lower stop layer 14, a low-k lower dielectric layer 16, an upper stop layer 18, a low-k upper dielectric layer 20, and a hard mask layer 42. (*Id.* at col. 6, line 56 - col. 7, line 31).

However, as admitted by the Examiner, "*Li* does not teach etching BCB with a mixture of CF_4 and N_2 ." (*Final Office Action*, p. 3, line 21). Additionally, *Li* fails to teach or suggest a processing gas having a flow rate ratio of CF_4 and N_2 within a following range: $(\text{N}_2 \text{ flow rate} / \text{CF}_4 \text{ flow rate}) \geq 1$ to prevent an occurrence of an etching stop and $(\text{N}_2 \text{ flow rate} / \text{CF}_4 \text{ flow rate}) \leq 4$ to prevent an occurrence of bowing, as required by Applicants' claim 14 (emphases added).

Thus, in order to cure the deficiencies of *Li*, the Examiner relies on *Jiang* for its alleged use of “CF₄ and C₄F₈[,] or a mixture of the two...[,] combined with N₂[,] to etch an organic silicate.” (*Final Office Action*, p. 3, lines 22-23).

Jiang discloses a dual damascene process for low-k or ultra low-k dielectrics, such as organo-silicate glass (OSG), wherein a trench 121 is etched in the OSG layer 108. “The etch chemistry for the trench etch is critical. One proposed etch for etching OSG is C₄F₈/N₂/Ar.” (*Jiang*, col. 3, lines 53-54).

Jiang, however, fails to explicitly teach or suggest wherein a flow rate ratio of CF₄ and N₂ in a processing gas is set within a following range: (N₂ flow rate / CF₄ flow rate) ≥ 1 to prevent an occurrence of an etching stop and (N₂ flow rate / CF₄ flow rate) ≤ 4 to prevent an occurrence of bowing (emphases added).

The Examiner alleges that “[i]t would have been obvious to one skilled in the art to use CF₄ in addition to, or in lieu of, the C₄F₈ that *Li* uses to etch the silicon-containing organic material because *Jiang* teaches that C₄F₈ and CF₄ are functionally equivalent with respect to etching a silicon-containing organic material.” (*Final Office Action*, p. 3, line 24 - p. 4, line 2). Applicants respectfully disagree. As disclosed in *Jiang*, “C₄F₈ is a higher-polymerizing fluorocarbon...Because CF₄ is a less-polymerizing fluorocarbon, adding it to the etch chemistry increases the etch rate significantly” (emphases added). (*Jiang*, col. 3, line 54 - col. 4, line 15). Accordingly, it is unreasonable to presume that “[i]t would have been obvious to use a N₂:CF₄ ratio of between 1:1 and 4:1 because (1) to maintain a constant N:C ratio when changing between *Li*’s C₄F₈ to CF₄, *Li*’s 45:3 ratio between N₂ and C₄F₈ adjusts to a ratio between N₂ and CF₄ of 3.75:1...,” as alleged by the Examiner (*Final Office Action*, p. 4, ll. 2-5). The reaction of C₄F₈ in a system is

clearly distinct from the reaction of CF_4 in a system, where the distinction is due in fact to the different ratios of C:F in CF_4 and C_4F_8 .

Accordingly, with respect to independent claim 14, *Li* and *Jiang* fail to teach or suggest the claimed combination, including, *inter alia*:

“wherein a flow rate ratio of CF_4 and N_2 in the processing gas is set within a following range: $(\text{N}_2 \text{ flow rate} / \text{CF}_4 \text{ flow rate}) \geq 1$ to prevent an occurrence of an etching stop and $(\text{N}_2 \text{ flow rate} / \text{CF}_4 \text{ flow rate}) \leq 4$ to prevent an occurrence of bowing”.

The Examiner has therefore not met at least one of the essential criteria for establishing a *prima facie* case of obviousness, wherein “the prior art reference (or references when combined) must teach or suggest all the claim limitations.” See M.P.E.P. §§ 2142, 2143, and 2143.03. Accordingly, independent claim 14 is patentable over *Li* and *Jiang*. Applicants therefore request that the rejection of claim 14 under 35 U.S.C. § 103(a) be withdrawn.

III. NEW CLAIM

New claim 18, though of different scope from claims 1 and 14, recites limitations similar to those set forth above with respect to claims 1 and 14. Specifically, claim 18 recites in pertinent part “introducing a processing gas into the airtight processing chamber, the processing gas containing N_2 and C_4F_8 ...[and] wherein a flow rate ratio of N_2 and C_4F_8 in the processing gas is set within a range of $(\text{N}_2 \text{ flow rate} / \text{C}_4\text{F}_8 \text{ flow rate}) \geq 10$ to prevent an occurrence of an etching stop.” Claim 18 is therefore allowable for at least the reasons presented above.

IV. CONCLUSION

Applicants respectfully request that this Amendment under 37 C.F.R. § 1.116 be entered by the Examiner, placing claims 1-5, 14, and 18 in condition for allowance. Applicants submit that the proposed amendments of claims 1 and 14 do not raise new issues or necessitate the undertaking of any additional search of the art by the Examiner, since all of the elements and their relationships claimed were either earlier claimed or inherent in the claims as examined. Therefore, this Amendment should allow for immediate action by the Examiner.

Furthermore, Applicants respectfully point out that the final action by the Examiner presented some new arguments as to the application of the art against Applicants' invention. It is respectfully submitted that the entering of the Amendment would allow the Applicants to reply to the final rejections and place the application in condition for allowance.

Finally, Applicants submit that the entry of the amendment would place the application in better form for appeal, should the Examiner dispute the patentability of the pending claims.

In view of the foregoing remarks, Applicants submit that this claimed invention, as amended, is neither anticipated nor rendered obvious in view of the prior art references cited against this application. Applicants therefore request the entry of this Amendment, the Examiner's reconsideration and reexamination of the application, and the timely allowance of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

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Dated: August 29, 2007

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